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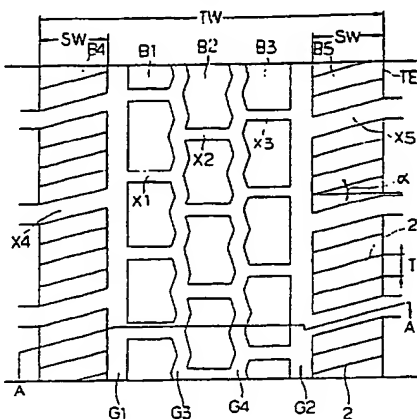
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54 Radial tyre.

57 A radial tyre having a tread provided with a pair of main grooves (G1, G2) extending circumferentially of the tyre and a plurality of lateral grooves (X1, X2, X3, X4, X5) extending axially of the tyre between the main grooves (G1, G2) to form a block type tread pattern or a centre block shoulder rib type tread pattern in which the tread (1) is provided with sipes (2) in both side region (B4, B5) which have a width of 10 to 35% of the overall width of the tread, the sipes (2) extending from the tread edges, the sipes (2) are arranged at intervals of 8 to 20mm in the circumferential direction of the tyre, the sipes (2) are inclined with respect to the axial direction of the tyre by 5 to 25 degrees, and further the depth of each sipe is 20 to 120% of the length of the main grooves. The resultant tread equalises the ground contact pressure distribution across the tyre tread.

FIG.1



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EP 0 333 397 A2

## RADIAL TYRE

The present invention relates to a pneumatic radial ply tyre and more particularly a block or block rib type tread pattern tyre.

In general, radial ply tyres are provided, radially outwardly of a toroidal carcass reinforced by steel or organic fibre cords, with a belt comprising a plurality of plies of steel cords arranged at angles of 15 to 70 degrees with respect to the circumferential direction of the tyre. Accordingly, the tread portion of such a radial tyre is substantially rigid, and as a result, the ground contact pressure becomes less in both side regions compared to the central region. Also the amount of slip of the tread on the ground is greater in the side regions than in the central region. Thus, uneven wear in the side (shoulder) regions of the tread, so called shoulder wear, is liable to happen. This problem is a particular problem in heavy duty tyres for truck and buses.

To try to solve this problem, it has been proposed, as shown in Fig.11, to form a plurality of short cuts S in the edge regions of the tread so as to facilitate movement of the rubber in these regions and accordingly to reduce the apparent rigidity thereof and to lessen the slip of those regions on the ground. The cuts are arranged to extend parallel with the axial direction of the tyre, and the cuts are very short in length having a length of less than 5% of the overall tread width, and also they are shallow in depth.

Furthermore, in a tread divided by a pair of circumferentially extending zig zag main shoulder grooves and axially extending grooves to form shoulder blocks in both side regions as shown in Fig.12, it has been proposed to use a plurality of circumferentially spaced cuts, each extending from the main shoulder groove to the tread edge, across each shoulder block. The cuts S proposed and shown in Fig.11 were however, so short, and shallow that they did not control the distribution of the ground contact pressure in the widthwise direction of the tread, and so they were not effective in preventing uneven wear.

On the other hand, the shoulder blocks shown in Fig. 12 had projecting portions because the main shoulder grooves extend in a zig zag shape. These projecting portions were low in rigidity and moved easily. The cuts added further to this decrease in rigidity of the blocks, and so again caused uneven wear of the tread.

It is an object of the present invention to provide a radial ply tyre especially suitable for heavy duty use, in which the distribution of the amount of slip of the tread on the ground is evened out without deterioration in wet grip and traction to reduce uneven wear of the tread.

Accordingly one aspect of the invention provides a radial tyre having a tread provided with a pair of main grooves extending circumferentially of the tyre and a plurality of lateral grooves extending axially of the tyre at least between the main grooves to form thereon either a block type tread pattern or a block rib type tread pattern having shoulder rib characterised in that the tread is provided with sipes across both side regions 10 to 35% of the overall width of the tread the sipes extending from the tread edges, the sipes being spaced apart at intervals of 8 to 20 mm in the circumferential direction of the tyre, the sipes being inclined with respect to the axial direction of the tyre by 5 to 25 degrees and the depth of each sipe being 20 to 120% of the depth of the main grooves.

The sipes preferably gradually increase in depth towards the respective edges of the tread.

In the present invention, a sipe means a cut having no width formed by using a thin blade after vulcanisation of the tyre 7, so that the sipe has substantially no groove width.

Embodiments of the present invention will now be described by way of example only, in conjunction with the attached diagrammatic drawings in which:

Fig.1 is a partial plan view showing an embodiment of the present invention

Fig.2 is a sectional view taken along the line A-A of Fig.1

Fig.3 is a diagram showing distribution of ground pressure in the widthwise direction of tread

Fig.4 is a diagram showing distributions of the amount of tread slip in the widthwise direction of the tread

Figs 5 to 7 are left half plan view showing treads of the embodiments of the present invention

Figs 8 to 10 are sectional views taken along the line B-B of Fig 6 showing the sipe and modifications thereof, and

Figs 11 and 12 are partial plan view showing tyres according to the prior art.

In Figs 1 & 2 a tread 1 is provided with a pair of circumferential extending straight main grooves G1 and G2 one on each side of the tyre equator, a pair of circumferential extending zig zag main grooves G3 and G4 between the straight main grooves, and a plurality of axially extending lateral grooves X1, X2, X3, X4, X5, whereby the tread is divided into two rows of side blocks B4 and B5, and three rows of central blocks

B1, B2 and B3. By using such block type tread pattern, the tyre is provided with good wet performance and good on snow performance such as traction.

Further, the tread is provided with parallel sipes 2 which extend straight from the tread edges TE to the straight main grooves G1 and G2 across the side blocks B4 and B5

5 The sipes 2 are formed in each side region SW of the tread extending axially inwardly for 10 to 35% of the overall width TW of the tread from each tread edge (TE). That means that the length of each sipe in the axial direction of the tyre is 10 to 35% of the tread width TW.

The sipes 2 are arranged at intervals T of 8 to 20 mm in the circumferential direction around the tyre.

Each sipe 2 is inclined at angle (alfa) of 5 to 25 degrees with respect to the axial direction of the tyre.

10 The depth D of each sipe 2 is 20 to 120% of the depth DB of the lateral grooves.

The sipes 2 reduce the rigidity in compressive and bending deformation of the tread rubber in the side regions, and the tread rubber can thus be easily bent and pressed to the ground. Accordingly, the ground pressure in the side regions is increased and the amount of slip thereof is decreased. As a result, uneven wear in the shoulder regions is reduced, and traction and braking forces are improved. Furthermore, the  
15 sipes 2 open on contact with the ground and close on leaving the ground so that the edges formed by opening of the sipes give improved wet grip.

If the sipes are too shallow, the above mentioned effects are not obtained. On the other hand, if the sipes are too deep, the rigidity of the tread becomes too small and the tread is liable to have portions torn off and thus be damaged.

20 The above mentioned depth D of the sipes 2 is more preferably in the range of 50 to 100% of the depth DB of the lateral grooves.

If there are different depth lateral grooves in the tread, then the above mentioned depth DB is defined as the deepest one.

If the angle (alfa) is smaller than 5 degrees the central portion of the side blocks B4, B5 is decreased in  
25 rigidity, and the wear resistance and strength thereof become too little. On the contrary, if more than 25 degrees, the amount of slip increase, and the meritorious effect of the sipes is lost.

Several kinds of sipes with different lengths and/or different depths may be combined in one tread.

Furthermore, if the interval T is smaller than 8mm, the wear resistance and the strength thereof are decreased. On the contrary, if it is larger than 20mm, the rigidity of the tread side regions becomes too  
30 high, and the amount of slip thereof or uneven wear is not reduced.

A second embodiment, not illustrated is a pattern of the shoulder rib/central block type. Such a pattern has straight main grooves defined in rib continuous rib in each shoulder of the tyre and in the central region transverse grooves form blocks. In this case the sipes extend straight from the tread edge across the shoulder ribs to the straight main grooves. They work in the same way as described for the first  
35 embodiment.

In the other embodiments shown in the Figs. 5, 6 & 7 the right half may be formed either in a line symmetry with respect to the centre line C, or in a point symmetry with respect to the centre line C.

In the tyre of Fig. 5 the tread is provided with two rows of side blocks B4 and B5 formed by circumferentially extending straight main grooves G1 and G2 and lateral grooves X4 and X5 (B5, G2 and X5  
40 are not shown in Fig.5). Each sipe 2 extends from the tread edge TE to the main groove (G1 or G2) across the side block, similarly to the tyre 1 of Fig. 1. And further, the tread is provided with a row of centre blocks b1 formed by the main grooves G1 and the lateral grooves X1.

In the tyre of Fig.6 the tread is provided with two rows of side blocks B4 and B5 formed by circumferentially extending straight main grooves G1 and G2 and lateral grooves X4 and X5 and a row of  
45 centre blocks B1 formed by the main grooves G1 and lateral grooves X1, similarly to the tyre of Fig.5. Each sipe 2 extends across the side blocks B4 from the tread edge TE into the central blocks B1 beyond the straight main groove G1, so that additionally slip of the block edges on each side off the straight main groove is reduced. As a result, the generation of so called railway wear is effectively prevented.

Further, each sipe 2 is provided axially outside its inclined main portion S2 with an axial portion S1  
50 substantially parallel to the axial direction of the tyre.

The axial length W1 of the axial portion S1 is not more than 10% of the tread width TW, and not more than 50% of the axial length SW of the sipe 2.

Preferably, the angle of the axial portion S1 to the axial direction of the tyre is not more than 5 degrees, whereby the slip of the tread edge portions is reduced and edge wear is effectively prevented.

55 In the tyre of Fig. 7, the tread thereof is provided with two rows of side blocks B4 and B5 formed by circumferentially extending straight main groove G1 and G2 and lateral grooves X4 and X5 (B5 and X5 are not shown in Fig.5). A row of centre blocks B1 is formed by the main grooves G1 and lateral grooves X1. Each sipe 2 extends from the tread edge to the straight main G1, G2, grooves across the side block B4, B5.

Also, each sipe 2 is provided axially outside and inside its inclined main portion S2 with an axial portion S1 and an axial portion S3, respectively. Both of the outer axial portion S1 and inner axial portion S3 are substantially parallel to the axial direction of the tyre.

The axial length W2 of the main portion S2 is not less than 50% of the axial length SW of the whole sipe 2.

Figs. 8 to 10 are sectional views showing modifications of the sipe based on the example of Fig 6 taken along the line B-B.

In Fig. 8 the depth D of the sipe 2 is constant in the axial direction of the tyre.

In Fig.9 the depth D is gradually decreased toward the tread edge TE from its inner end.

In Fig.10, the axial portion S1 is deeper in depth than the main portion S1. The main portion may be inclined. Such changes in the cut depth in the axial direction of the tyre can control the ground pressure distribution in the widthwise direction of the tread.

These modifications as shown in Figs.8 to 10 can be applied to the sipes of Figs. 1, 5 and 7.

The depth DB of the lateral grooves to define the side blocks B4 and B5 is not more than the depth DO of the main grooves G1, G2. The depth DO of the lateral grooves to define the central blocks is not more than the depth DO of the main groove.

#### Comparative Tests

Test tyres, 10.00R20 steel radial tyres for truck and bus were made by way of trial, according to the specifications given in Table 1.

The test tyres of Ref. 10 and Ref. 11 were provided with the tread patterns of Figs.11 and 12, respectively.

The rest were provided with the tread pattern of Fig. 1, in which all of the lateral grooves X1 - X5 had the same depth as the depth DO of the main grooves (DB = DC = DO)

Each kind of tyre was mounted on the front wheels of a vehicle, and the shoulder wear, that is, the uneven wear of the tyre shoulder portions was measured after a 30,000 km run. Also the tyres were examined for railway wear. The results of the tests are also given in Table 1. As to shoulder wear, the results are expressed by an index based on the assumption that Ref. 1 is 100, wherein the smaller the index, the less is the wear and accordingly the resistance to wear is better.

Table 1 a

	Ex.1	Ex.2	Ex.3	Ex.4	Ex.5	Ex.6	Ex.7
SW/TW (%)	25	20	20	20	20	20	20
D/DB (%)	75	100	75	75	75	75	50
alfa (deg)	20	20	10	15	25	5	20
Thickness (mm) of sipe	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Intervals (mm)	15	15	15	15	20	8	15
Shoulder wear (index)	50	60	50	45	65	68	60
Rail-way wear	non	non	non	non	non	non	non

Table 1 b

	Ref.1	Ref.2	Ref.3	Ref.4	Ref.5	Ref.6
SW/TW (%)	20	5	5	5	10	10
D/DB (%)		15	75	125	25	100
alfa (deg)		20	20	20	20	20
Thickness (mm) of sipe		0.2	0.2	0.2	0.2	0.2
Intervals (mm)		15	15	15	5	25
Shoulder wear (index)	100	85	80	*1	80	94
Rail-way wear	non	non	non	non	non	non
*1, *2: Tread failure was occurred.						

Table 1 c

	Ref.7	Ref.8	Ref.9	Ref.10	Ref. 11
SW/TW (%)	20	20	25	5	20-25
D/DB (%)	75	75	75	75	75
alfa (deg)	28	3	20	0	0
Thickness (mm) of sipe	0.2	0.2	0.5	0.2	0.2
Intervals (mm)	15	15	15	15	15
Shoulder wear (index)	90	*2	*3	80	55
Rail-way wear	non	non	non	generated	generated
*1, *2: Tread failure was occurred.					
*3: Uneven wear was occurred on both sides of each sipe in the circumferential direction of the tire.					

Further, for the tyres of Ref. 1 and Ex 1 and Ex 5, the distributions of the ground pressure and the slip thereof in the widthwise direction of the tread were measured, and the measurements are shown in Figs. 3 and 4 respectively.

It is apparent from Figs 3 and 4 that the tyres according to the present invention were improved in uniformity for both ground pressure distribution and the amount of slip distribution.

As mentioned above, according to the present invention, the sipes in a block type or a crown block shoulder rib type tread pattern, are optimised in terms of depth intervals angle at which the sipes are arranged, and range in which the sipes are formed, so as to equalise the ground pressure distribution in the widthwise direction of the tread. As a result, the amount of slip is decreased in the shoulder portions, and thus uneven wear is effectively prevented.

By the way, the circumferential main grooves which define the side blocks or the side blocks or the side ribs is straight, so that the rigidity of the side blocks or the side ribs is unified, and shoulder wear and railway wear are effectively prevented without deteriorating wet grip and traction.

## Claims

1. A radial tyre having a tread (1) provided with a pair of main grooves (G1, G2) extending circumferentially of the tyre and a plurality of lateral grooves (X1, X2, X3, X4, X5) extending axially of the tyre at least between the main grooves (G1, G2) to form thereon either a block type tread pattern or a block rib type tread pattern having shoulder ribs characterised in that a tread (1) is provided with sipes (2) across both side regions which have a width of 10 to 35% of the overall width of the tread, the sipes (2) extending from the tread edges, (TE) the sipes (2) are spaced apart at intervals of 8 to 20 mm in the circumferential direction of the tyre, the sipes (2) are inclined with respect to the axial direction of the tyre by 5 to 25 degrees, and the depth of each sipe (2) is 20 to 120% of the depth of the main grooves (G1, G2).

2. A radial tyre according to claim 1, characterised in that the sipes (2) increase in depth gradually towards the respective edges (TE) of the tread.

3. A radial tyre according to claim 1 or 2 characterised in that each sipe (2) comprises an inclined main portion (S3) and a less inclined portion (S1, S2).

5 4. A radial tyre according to claim 1, 2 or 3 characterised in that sipe has an outer axial portion S1 deeper than the main portion S2.

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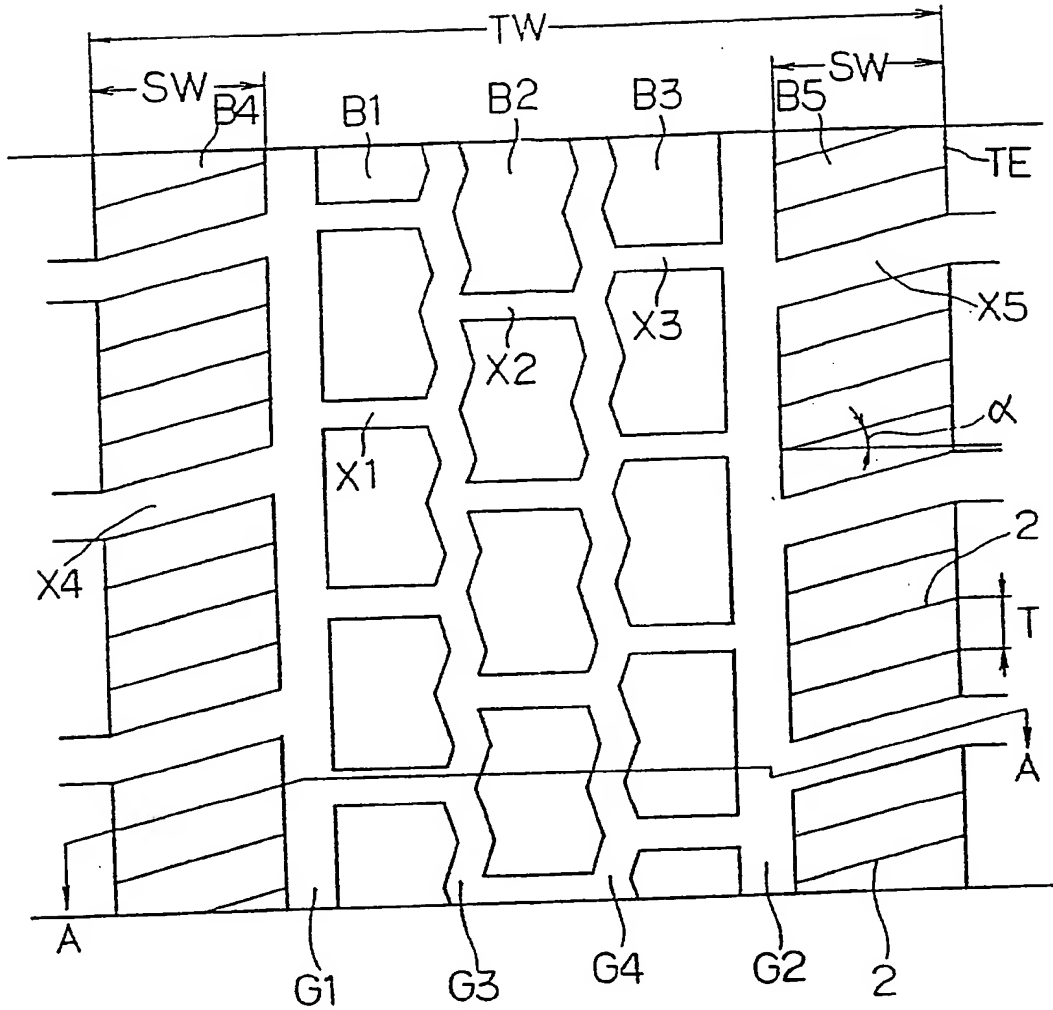
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**FIG.1**



**FIG.2**

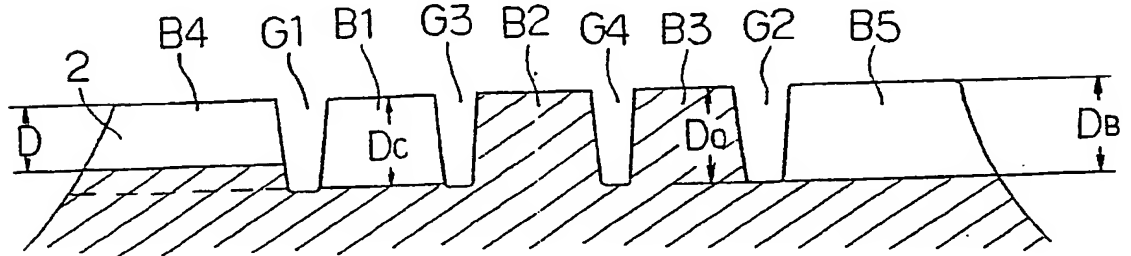


FIG.3

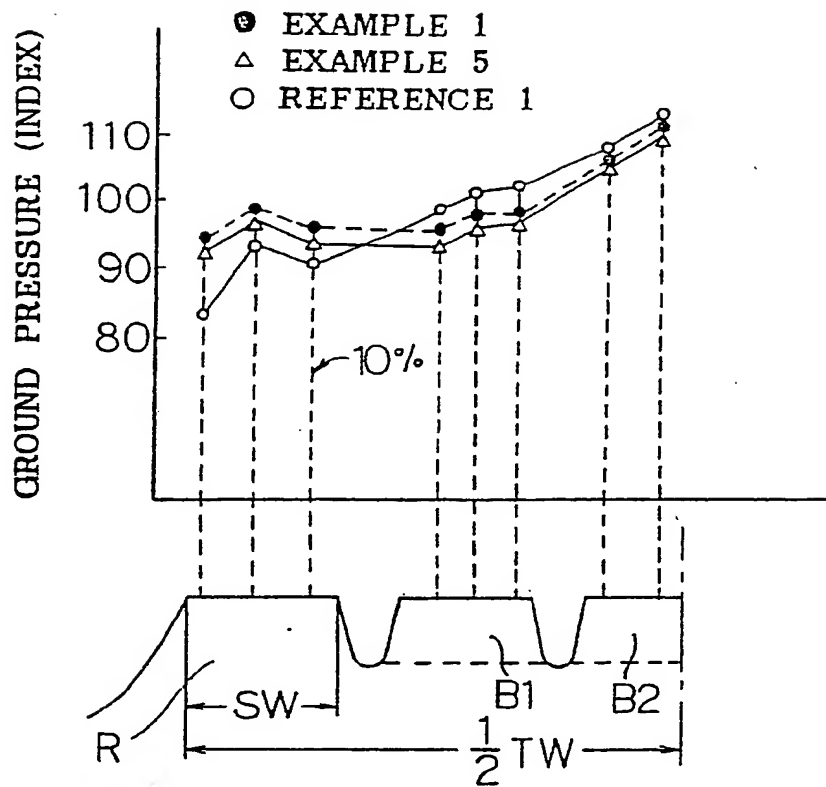
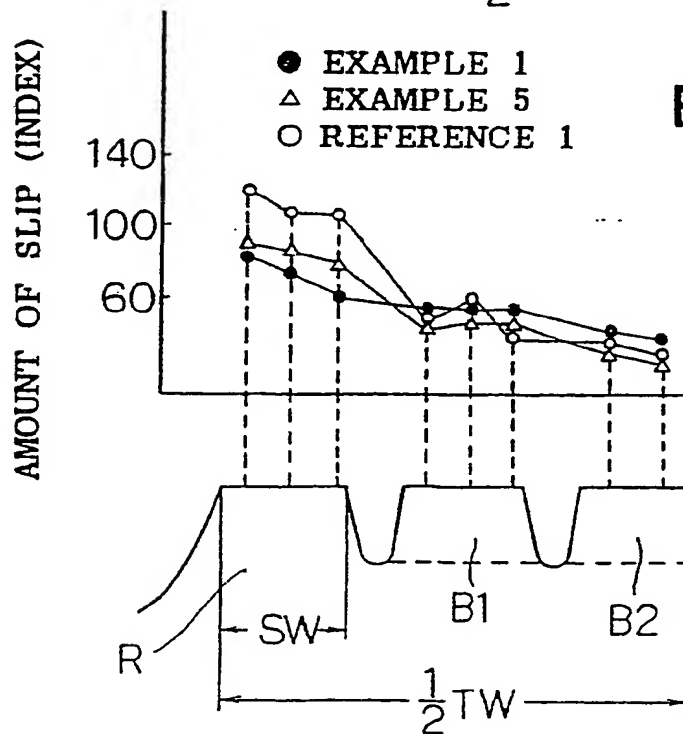
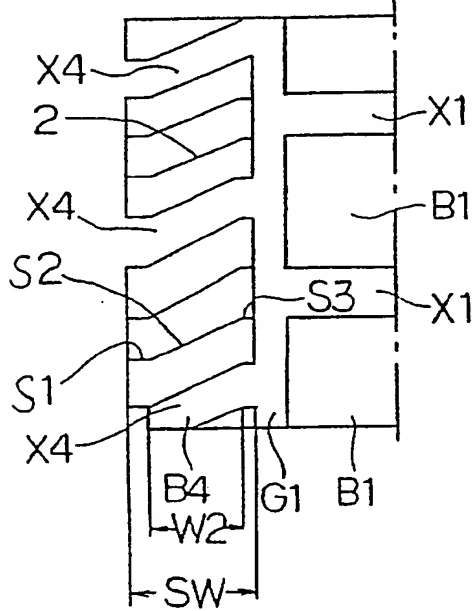
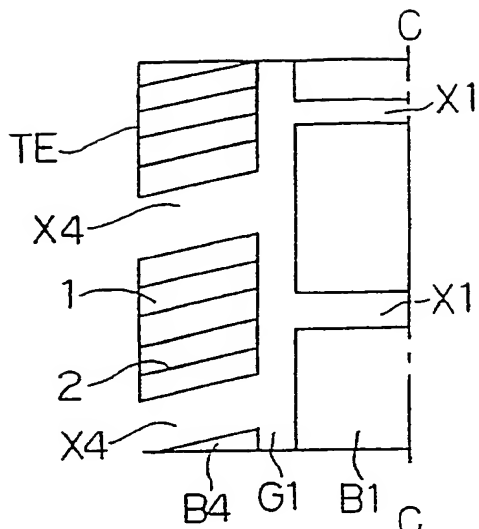


FIG.4



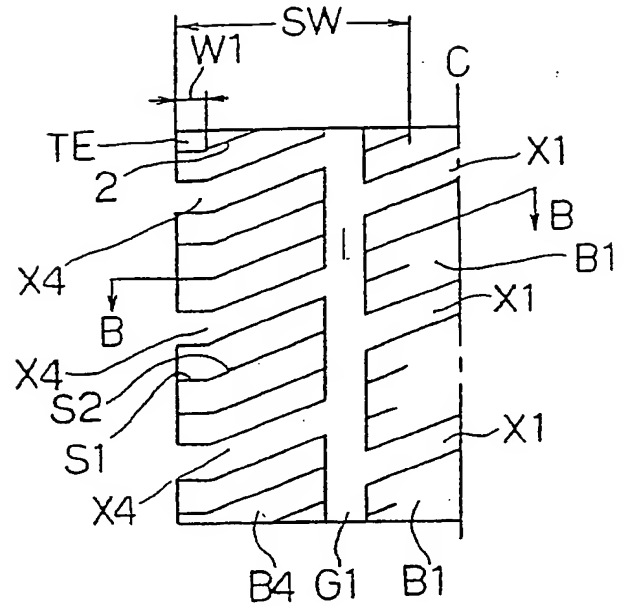


**FIG.5**

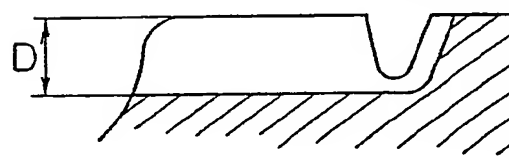


**FIG.7**

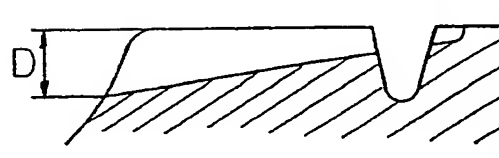
**FIG.6**



**FIG.8**



**FIG.9**



**FIG.10**

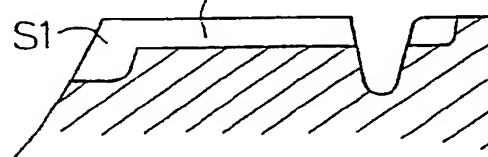


FIG.11

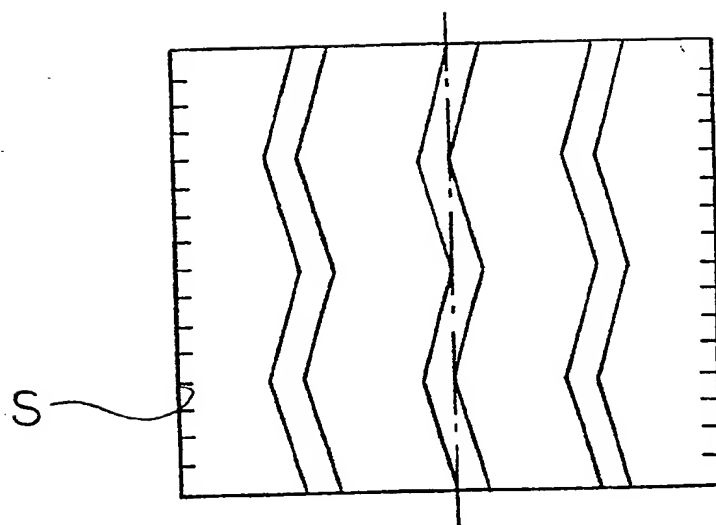
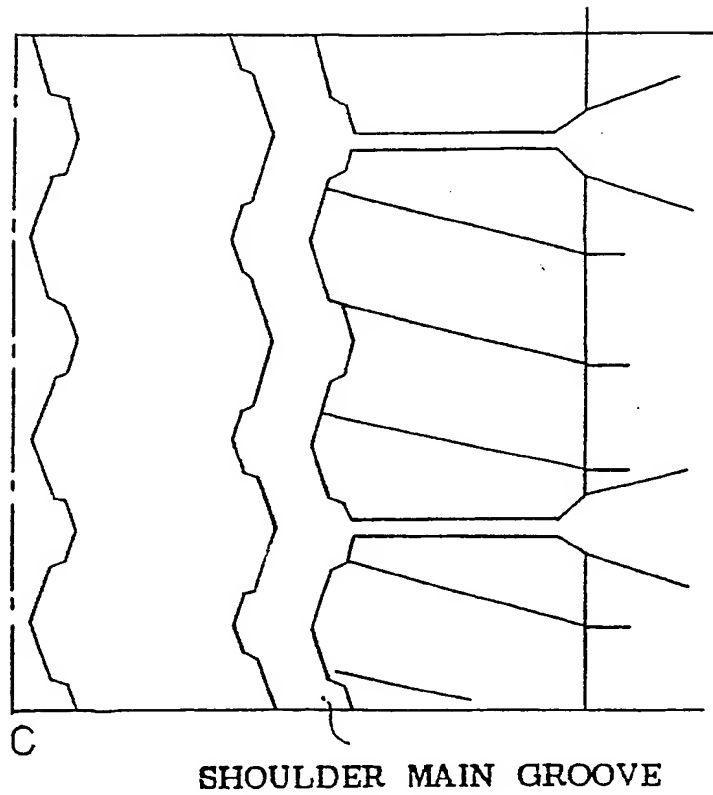


FIG.12



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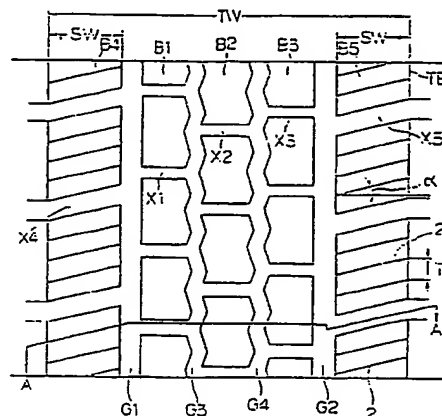
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FIG.1



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European Patent  
Office

# EUROPEAN SEARCH REPORT

Application Number

EP 89 30 2430

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 4)
P, Y	EP-A-0 282 252 (SUMITOMO RUBBER IND.) * Claims 1-3; page 3, lines 4-55 *	1-4	B 60 C 11/11 B 60 C 11/12
Y	EP-A-0 205 233 (SUMITOMO RUBBER IND.) * Claims 1-4 *	1-4	
A	EP-A-0 199 570 (SUMITOMO RUBBER IND.) * Claims 1-9 *	1,2	
A	GB-A-2 190 048 (BRIDGESTONE CORP.)		
A	FR-A-2 564 385 (SUMITOMO RUBBER IND.)		
A	DE-A-2 918 183 (CONTINENTAL GUMMI-WERKE)		
			TECHNICAL FIELDS SEARCHED (Int. Cl.4)
			B 60 C
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 13-09-1989	Examiner THEODORIDOU E.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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